

11. CONCLUSIONS

1. Paleogene marine sequences are well exposed in several sections throughout Sulaiman Range, Southern Indus Basin, Pakistan. So far no one has published any reliable, precise and high-resolution biostratigraphic zonal scheme based on planktonic foraminifera applicable to the Paleogene sequences of the Sulaiman Range and the whole Indus Basin. This is a first kind of research work on planktonic foraminiferal biostratigraphy carried on a number of representative sections from the Sulaiman Range in order to establish the Paleogene biostratigraphic.

2. After detailed route geological mapping and section measurements in all three sections, lithostratigraphic units are revised and new subdivision is given. Pab Sandstone is renamed as Pab Formation as it was an informal term for lithostratigraphic unit (Formation). The Shaheed Ghat Formation is revised which includes now the Drug Formation of Shah (1987; 1990).

3. The contact relationship of the Dughan, Shaheed Ghat, Baska and Kirthar Formation are revised. Based on field and lab observations, two unconformities are introduced that are between the Dughan Formation and the overlying Shaheed Ghat Formation and between the Baska Formation and the Kirthar Formation.

4. Late Paleocene to early-late Eocene Tethyan planktonic foraminifera is studied in detail. This sequence has yielded abundant and well-preserved

Paleocene-Eocene planktonic foraminifers. A total of 96 species and subspecies that belong to 17 genera were identified and recorded. A new species *Globanomalina rakhiensis* is described from the Rakhi Nala section, it also present in other two sections.

5. Zones P3 to P15 of the tropical zonal schemes were recognized based on identified planktonic fauna recovered from the Paleogene sequences of the Sulaiman Range. Moreover, twofold new subdivisions of the Zone P3 and P4 are made in this study. In addition to it, new definitions are made for biostratigraphic zones P9, P10, P14 and P15.

6. Late Paleocene through early Eocene age is assigned to the Dunghan Formation based on Zones P3 to P8 recovered from it.

7. Zones P6A to P10 are recognized from the Shaheed Ghat Formation and based on them early Eocene to early-middle Eocene age is assigned to it.

8. Baska Formation does not yield any determinable planktonic foraminifera, therefore the age assignment remains in question, however, as it lies between the Shaheed Ghat and the Kirthar Formations, therefore from its stratigraphic position, it may have the age of early-middle Eocene as it fall against established Zones P10 and P11.

9. Lower part of the Kirthar Formation (Pir Koh Limestone and Sirki Members) does not produce any determinable planktonic foraminifera. However, the upper part (Pir Koh Limestone and Marl Member, and the Drazinda Member) has produced well preserved planktonic foraminifera based on which P12 to P15

zones are established and therefore middle-middle Eocene to early-late Eocene age is assigned it.

10. Two faunal turnovers are recorded from the late Paleocene-early Eocene sequence of the Dunghan Formation from all three sections based on species relative abundance data. These faunal turnovers occurred at the Zones P3A/B and P4B/P5 boundary or within Zone P5, close to the Paleocene/Eocene boundary.

11. Paleocene/ Eocene transition boundary is placed within the Zone P5 based on the last appearance datum (LAD) of *Globanomalina pseudomenardii*, *Morozovella velascoensis* and first appearance datum (FAD) of the *M. subbotina*, *Pseudohastigerina wilcoxensis*, *M. formosa gracilis*, *M. formosa formosa*, and *M. lensiformis*. This interpretation is further confirmed by the identification of Benthic Foraminiferal Extinction Event (BFEE) with the Zone P5.

13. The gray-black colored siltstone sequence of the Dunghan Formation with limestone intercalations were mainly deposited in relatively deep waters since it produced highly diversified planktonic foraminiferal assemblage with higher P-ratios. The Shaheed Ghat Formation is interpreted as deposited in deep to shallow Sea as it contain rich planktonic fauna, planktonic foraminiferal mudstone-wackestone, and platy limestone/mudstone-micrite-dismicrite microfacies in the basal part and contain restricted fauna microfacies in the upper part. The Baska Formation is devoid of pelagic fauna and mainly consists of restricted fauna microfacies with anhydrite facies in the upper part clearly indicate signatures of regression related very shallow waters environment. Deep to open marine

environment of deposition is interpreted for the Kirthar Formation as it has micrite-dismicrite microfacies and pelagic wackestone microfacies in the base followed by restricted fauna to again pelagic wackestone microfacies in the upperpart.